

Ceiling and Visibility Weather Project

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NASA AWIN Program

NASA Langley

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C&V Requirements Abound

Federal Aviation Administration Safer Skies: A Focused Safety Agenda

**General Aviation
Weather Joint Safety Analysis
Team
Final Report
April 1999**

**Routine IMC— low ceilings or fog,
obscurations to visibility, rain, and snow --
were a cause or factor in an overwhelming
majority of fatal weather accidents, not only
for Part 91 operators**

Navy Pacific Meteorology and Oceanography Center – San Diego

Commanding Officer (CAPT
Gunderson) prepared following
statement regarding C&V following
Monterey meeting

The meteorological phenomena that have both the most impact on U.S. navy operations in the Southern California Operating Area, and are the most difficult to forecast, are low stratus and fog...

NASA Aviation Safety Program Evolution

- Aviation Safety Investment Strategy Team (ASIST)
- White House (Gore) Commission on Safety and Security
- Aviation Safety Program

Accident Data Summary

Accident Rate Data (approx)								
G/A		Commuter		Transport		Rotorcraft		
Fatal	Non-Fatal	Fatal	Non-Fatal	Fatal	Non-Fatal	Fatal	Non-Fatal	Atmospheric/ Weather Hazard
1	1	1	1	1	2	1	1	Ceiling & Visibility
								Fog/Haze
								Precipitation
								Clouds
								Night Ops
3	2	2	2	2	3	2	2	Convection and Winds
								Thunderstorms
								Hail
								Heavy Rain
2	1	2	2				1	Winds
		2		2				Wind Shear
3	3	3	3	3	1	3	3	Turbulence
								Convection
								Terrain Induced
								Jet Stream
								Tropopause
								Gravity Waves
								Frontal
2	3	1	2	1	3	2	2	Icing
								In-Flight
								Ground
								Induction (Dew Point)
3	3	3	3	3	3	3	3	Wake Vortex
3	3	3	3	3	2*	3	3	Volcanic Ash
3	3	3	3	2	3	3	3	Runway Contam.
			1	Significant Contributor to Accidents				
			2	Moderate Contributor to Accidents				
			3	Minimal Contributor to Accidents				

- Weather is a factor in approximately 30% of aviation accidents
- In addition, the majority of “CFIT” and “Loss of Control” accidents can be considered “visibility-induced crew error”, where better weather information or pilot vision would have been a substantial mitigating factor.
- Differences between most important fatal accident factors and general accident causes for different aircraft classes.(both important)

C&V: NAS Issues and Needs

- C&V Impacts on Aviation Safety
 - Major factor in GA fatalities
 - Contributing factor for many accidents
- C&V Impacts on NAS Delay
 - 85% of delay is Wx related
 - About Half of this is due to C&V
- Engineering Solutions
 - More Runways
 - Better Surveillance and Tracking
 - Vision Technology
 - Improved Information and Decision Aids
- Precision Weather Forecasting
 - Operationally significant changes: START & STOP
 - Match traffic to actual capacity
 - 0 to 4 hour forecasts

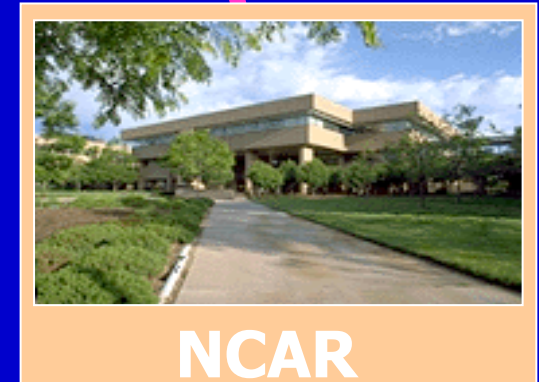
C&V Complexity

- Many meteorological causes
 - Visibility: Fog and heavy precipitation
 - Low Ceiling: Marine Stratus, Frontal Stratus, lifting fog
 - Radiative cooling and heating
 - Extra-tropical Storms (C&V is part of a precipitation event)
 - Regional Forcing (Advection)
- There is no single technical break-through that will cure the C&V problem
- Product selection is a balance of factors
 - technical risk
 - event frequency
 - development cost
 - leveraging
 - aviation benefits
- FAA C&V PDT focus is on Marine Stratus and Winter Storms
- Technology Spin-off to AWC



C&V

Forecast/Nowcast Improvement Program



NCAR



Objectives of C&V Program

- ➔ Examine ability of models to adequately describe ceiling and visibility
- ➔ Improve moisture physics of mesoscale models (COAMPS, MM5, RUC-II, etc.) with the understanding that such improvements are essentially interchangeable
- ➔ Compare mesoscale model C&V output with independent METAR comparison

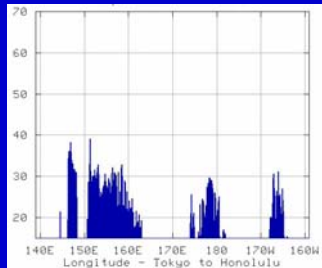
Objectives of C&V Program (Cont'd)

- ➔ Develop local area capability to provide improved C&V products (initial focus on SOCAL), to support NPMOC-SD, Los Angeles Center CWSU and TMU
- ➔ Develop ADDS-oriented C&V product for Aviation Weather Center
- ➔ Develop world-wide C&V forecast/nowcast improvement capability

Objectives of C&V Program (Cont'd)

- Use knowledge-based approach with multi-sensors/models to develop 0-6 hour nowcast
- Validate scientific skill of products
- Conduct operational demonstrations with users

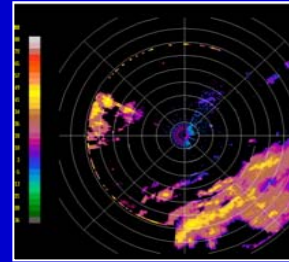
Fused Ceiling & Visibility Product



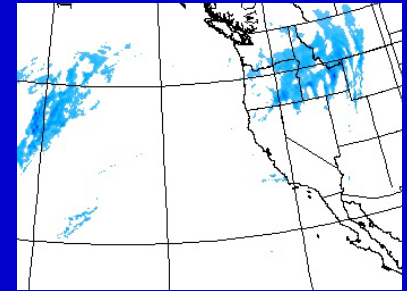
Convective Clouds
X-S



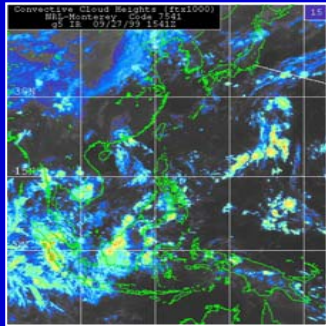
Model Ceiling &
Visibility Product



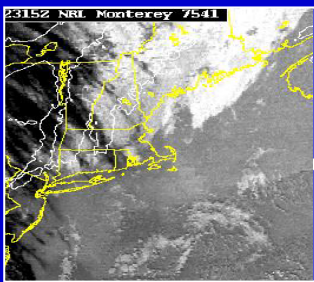
Radar Product



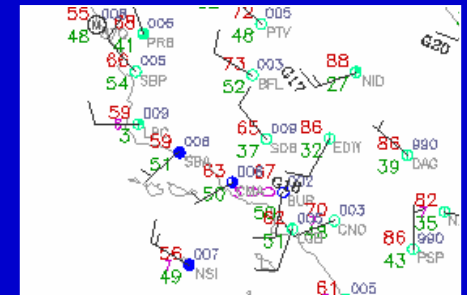
Rain Rate



Convective Cloud Ht



Satellite Low Cloud Product



Obs: METAR,
AIREP/PIREP

Assign Membership
Functions and Dynamic
Weights

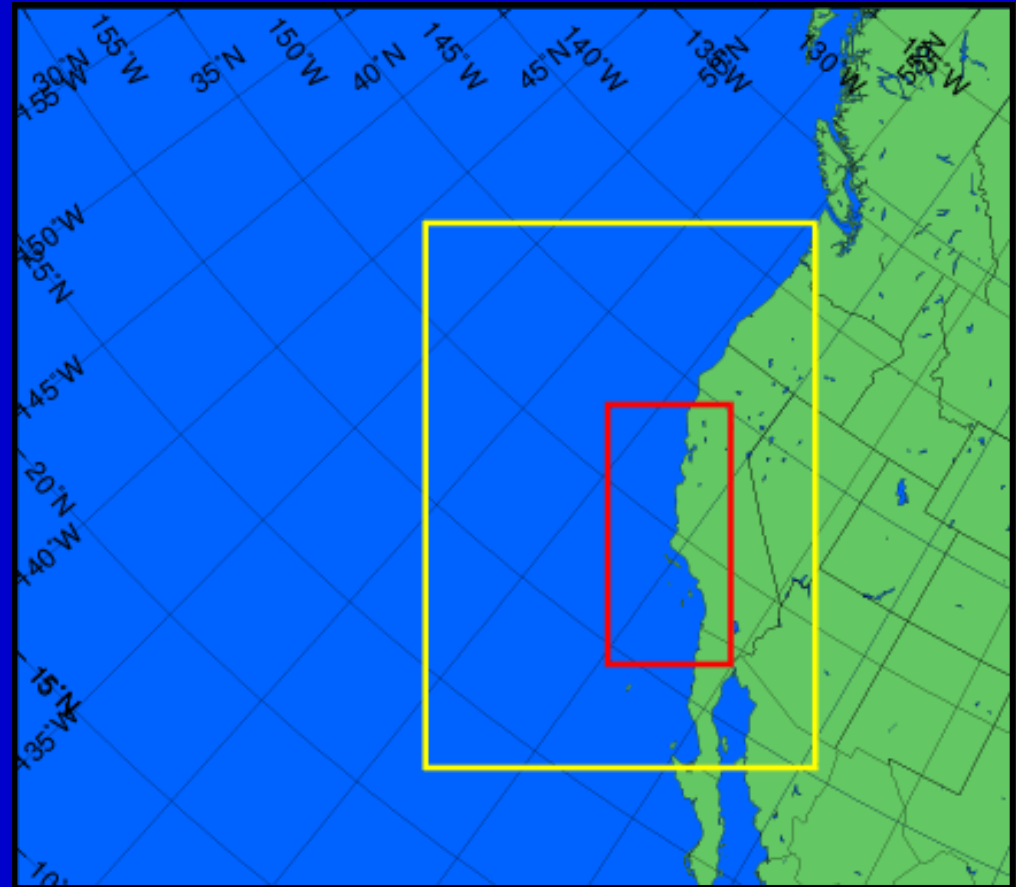
Automatic Verification

Fused C&V Product

Confidence Level

Forecasts

- NWP Model
 - COAMPS
- Grid
 - 81 km (black) 52 x 46
 - 27 km (yellow) 61 x 85
 - 9 km (red) 58 x 121
- Duration
 - Successive 12-hour forecasts
 - 6 months
- Forecasted Fields
 - Ceiling (unlimited > 9000 m)
 - Visibility (unlimited > 16.1 km)



**Data Fusion for Weather Assessment
(DaFWA)**

Stratus

2000-9000

1200-2000

900-1200

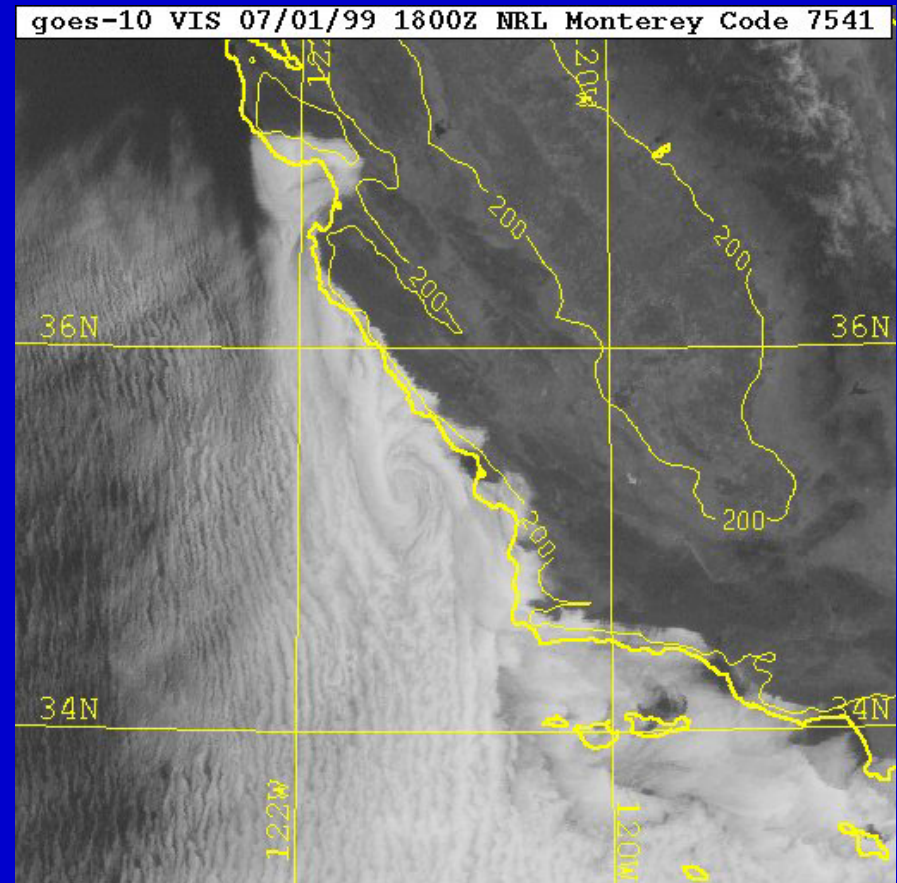
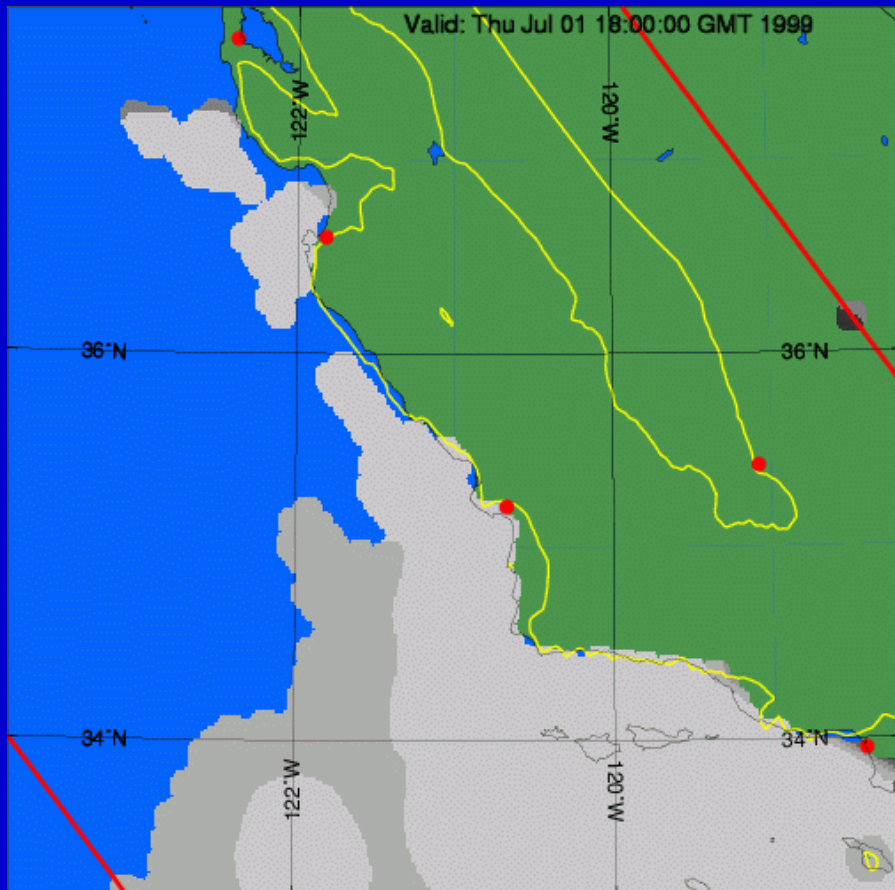
600-900

300-600

0-300

Cloud Ceiling Height (m)

Visible Satellite Image (1 km)

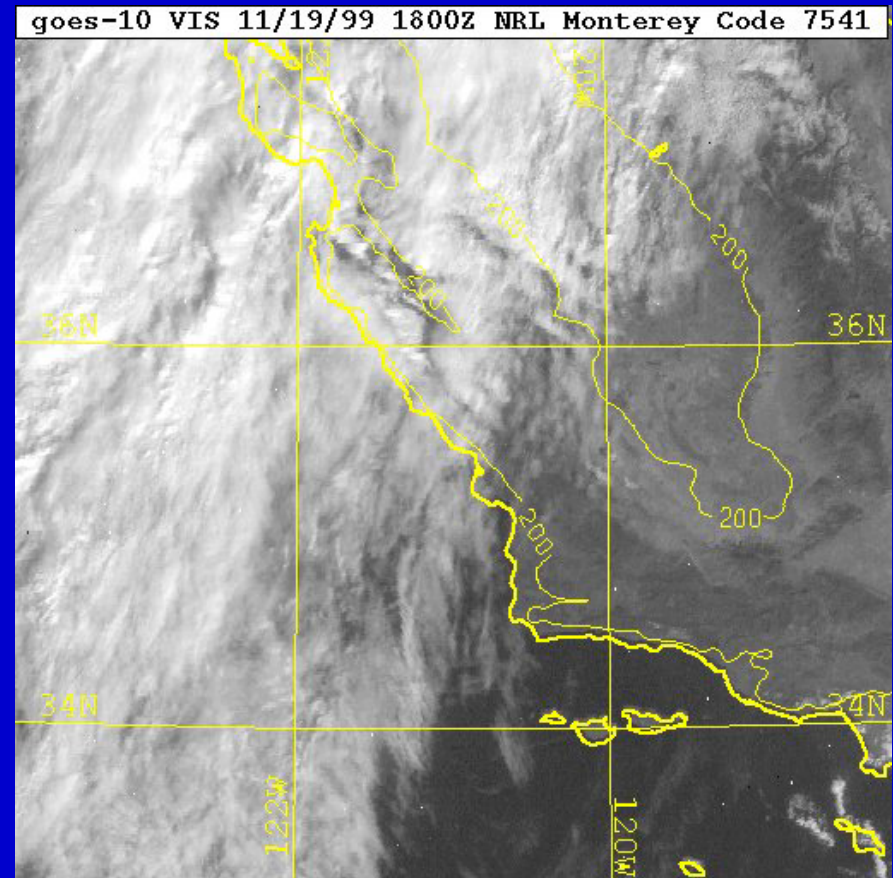
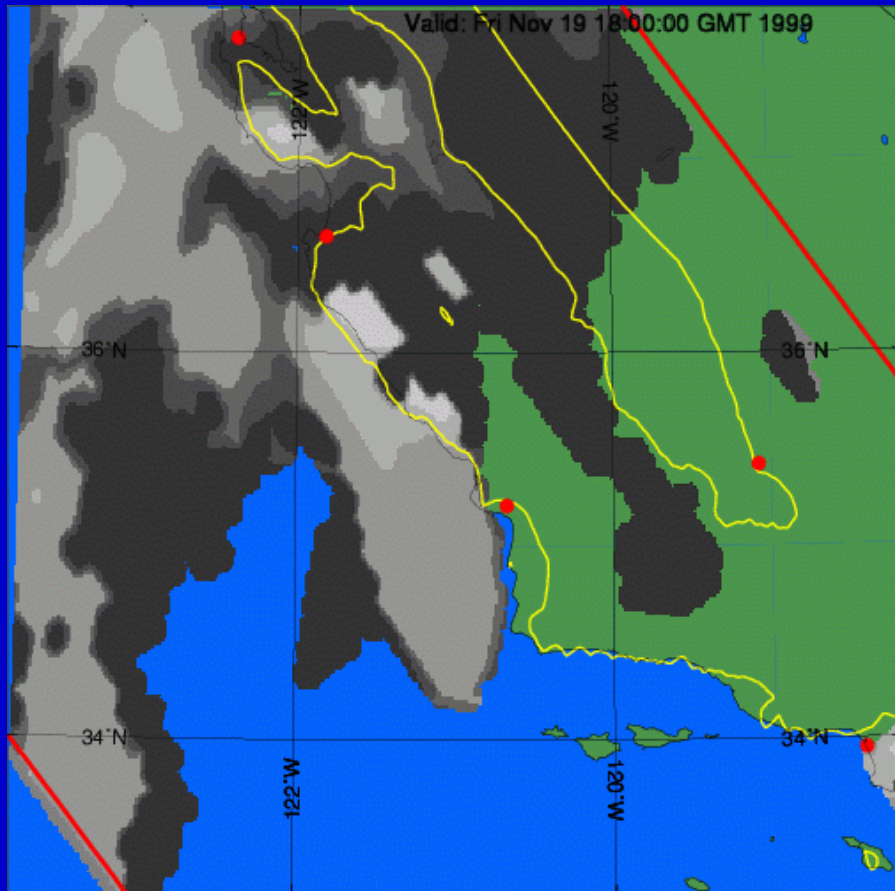


Fronts

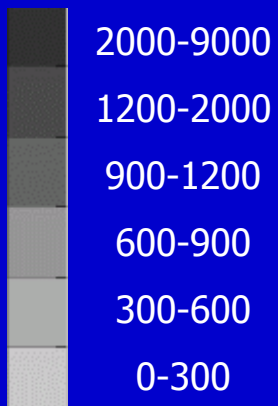


Cloud Ceiling
Height (m)

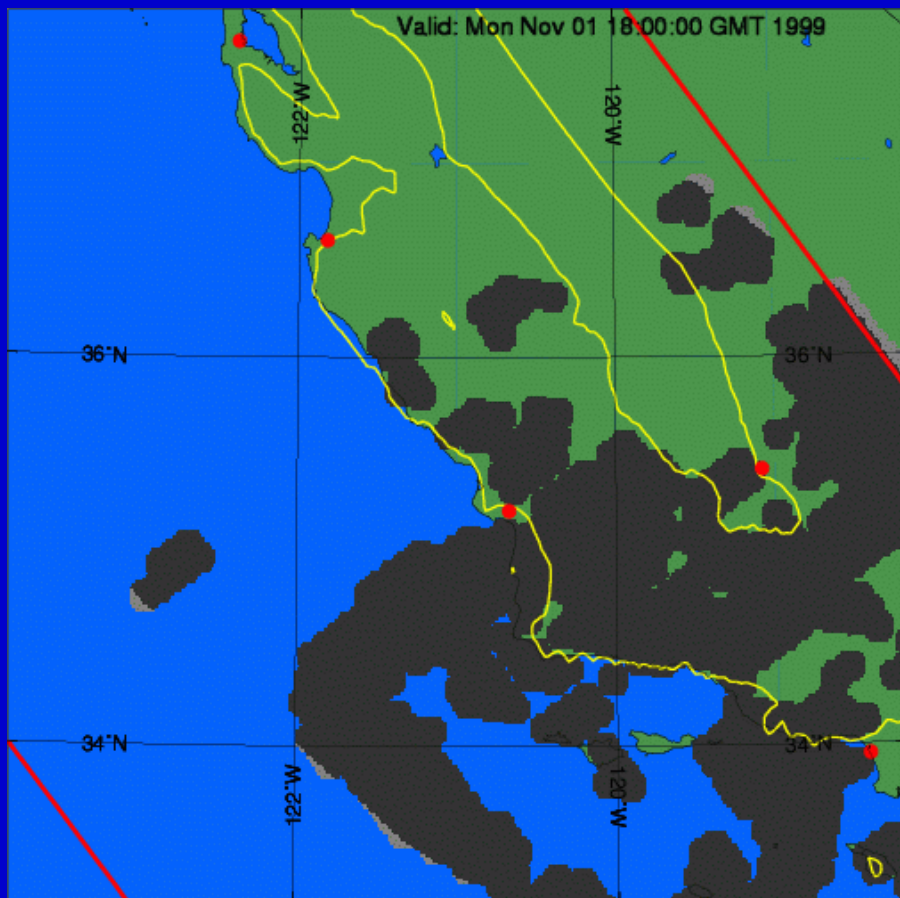
Visible Satellite
Image (1 km)



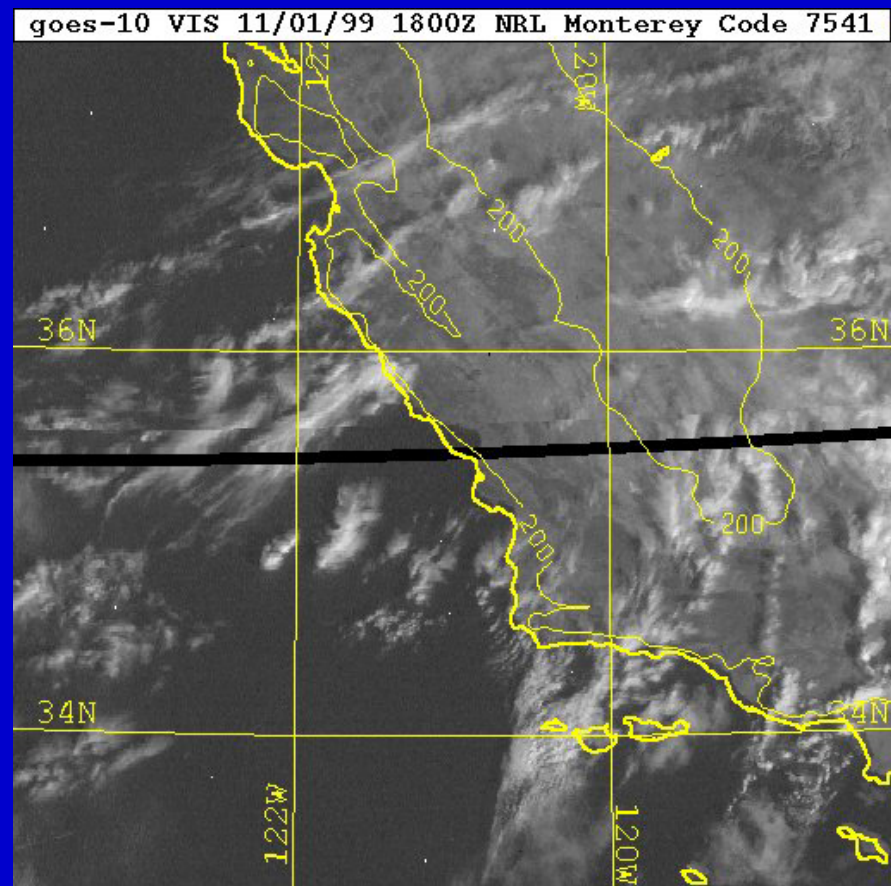
High Clouds



Cloud Ceiling
Height (m)



Visible Satellite
Image (1 km)



Forecasts vs. METAR

Monterey (KMRY)

San Luis Obispo (KSBP)

Los Angeles (KLAX)

Underpredicted low ceilings and low visibilities

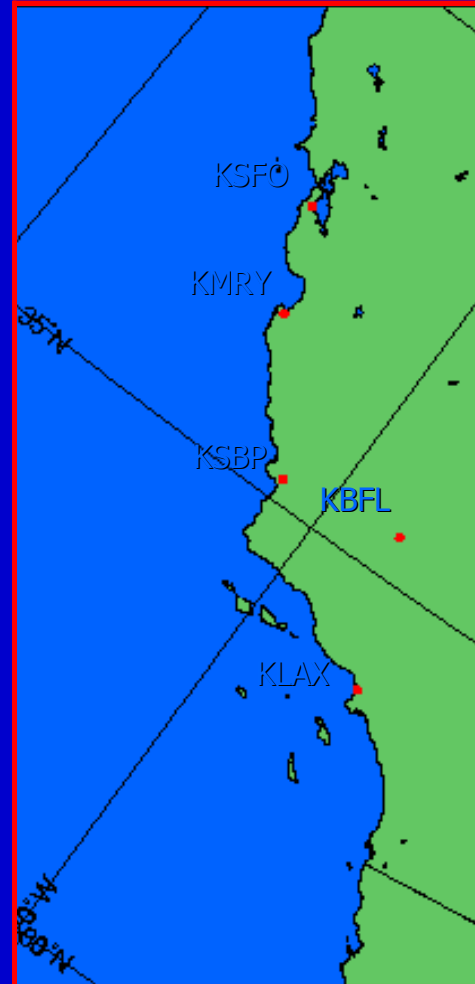
San Francisco (KSFO)

Overpredicted low ceilings and low visibilities

Bakersfield (KBFL)

Summer - Near Perfect

Fall - Underpredicted low visibilities



How close are the “missed” forecasts?

- ➔ Consider ceiling as unlimited or restricted
- ➔ When the model failed to predict a restricted ceiling height.....
- ➔how close was the correct forecast?

Percentage of closest correct forecasts within the yellow boxes

	Aug-Sep	Nov	Total
KLAX	47.8% (11/23)	65.6% (21/32)	58.2% (32/55)
KMRY	84.4% (27/32)	62.5% (15/24)	75.0% (42/56)
KSBP	87.0% (20/23)	54.5% (12/22)	71.1% (32/45)

Differences

- Topography
- Aerosols

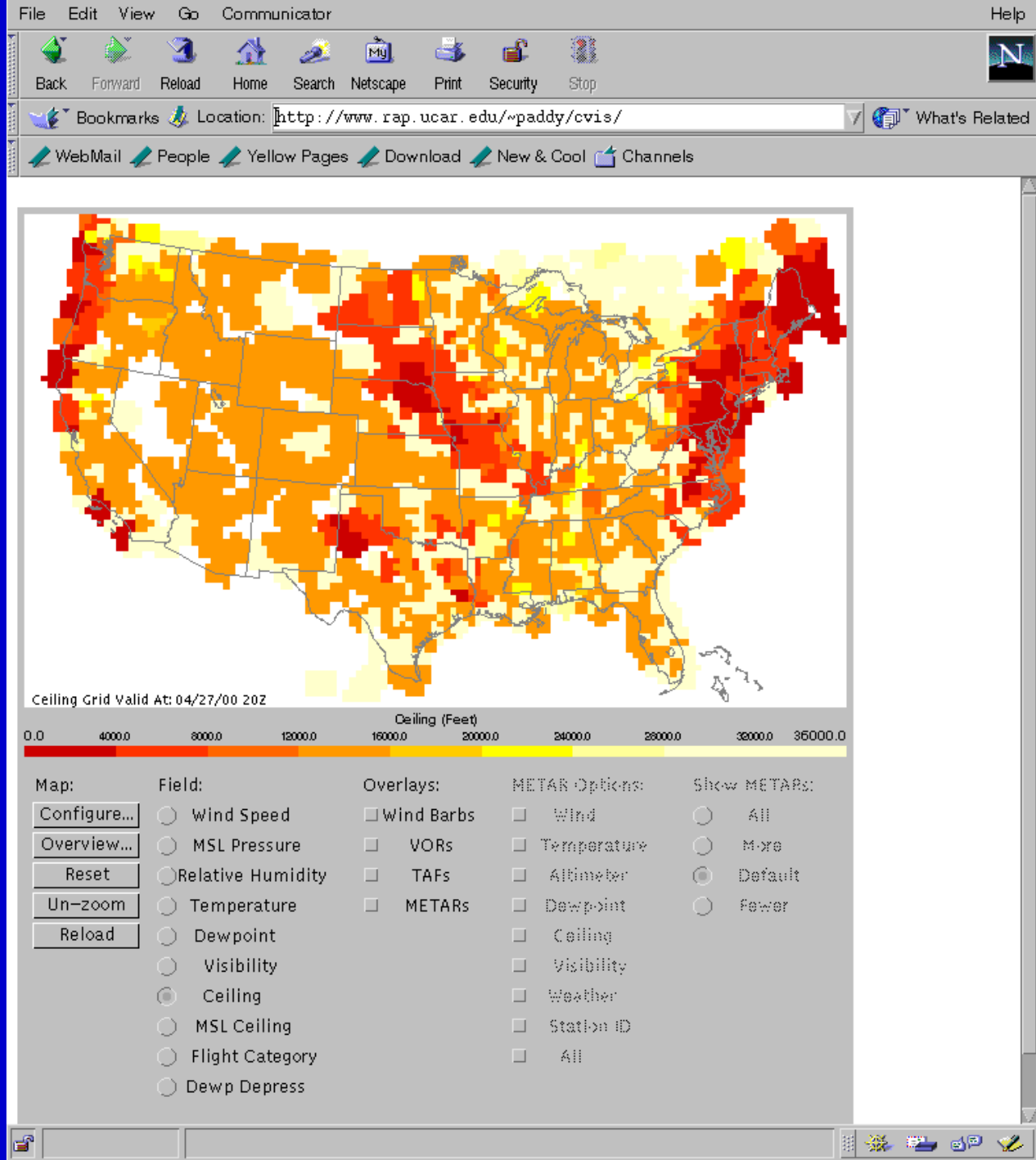


Conclusions

Qualitative - Good correlation between the ceiling height forecasts and satellite imagery (shape and timing)

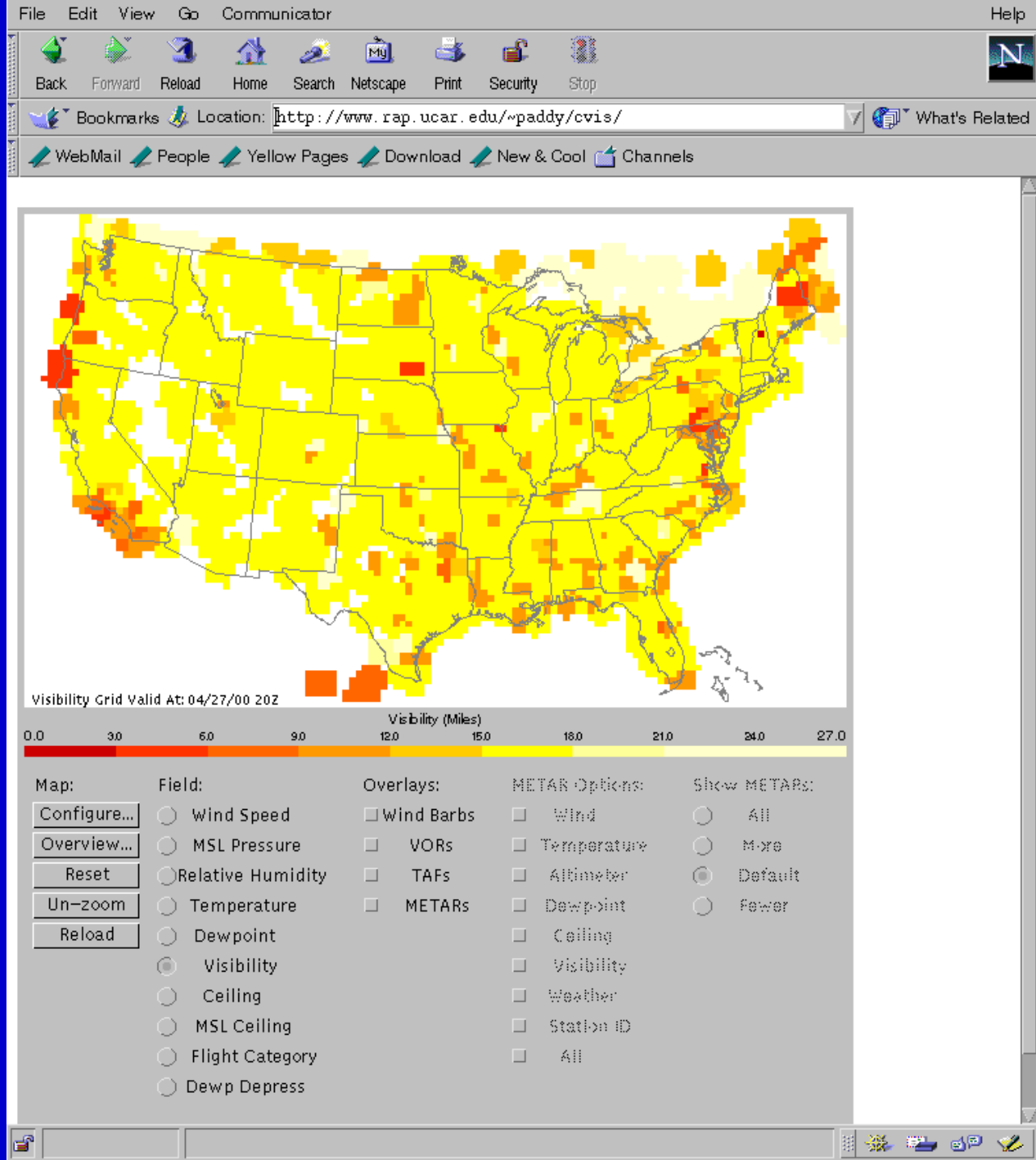
Quantitative - Poor correlation between observations and forecasts until surrounding gridpoints are considered

CEILING
04/27/00 20Z



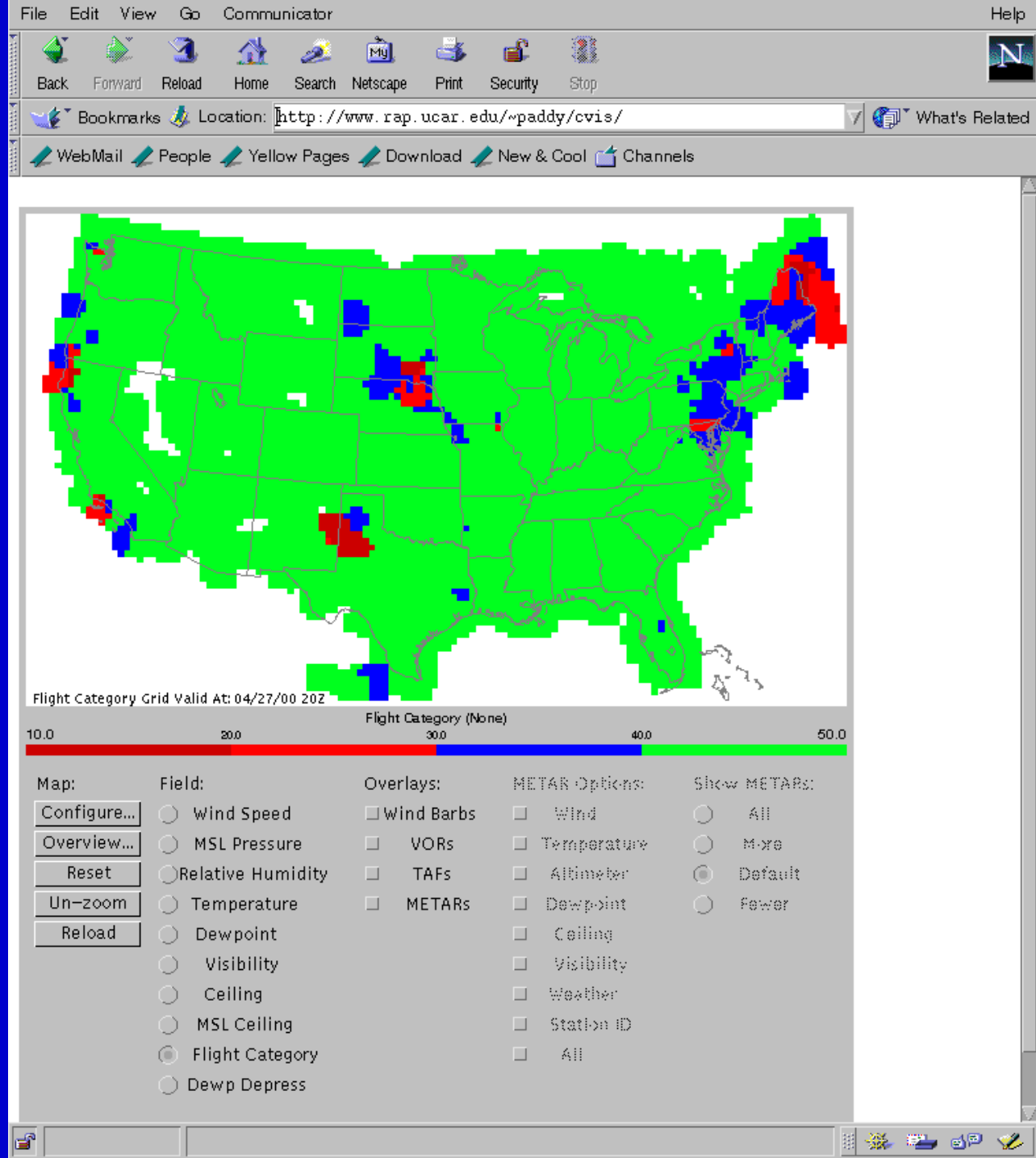
VISIBILITY

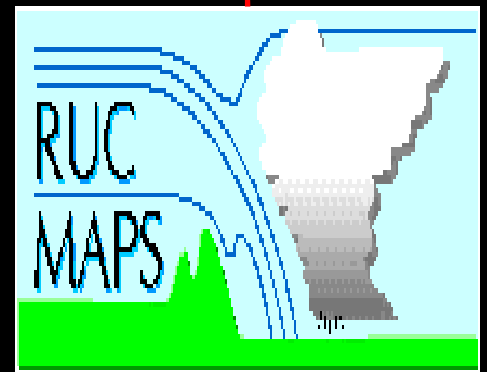
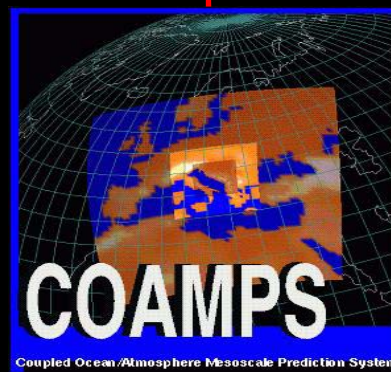
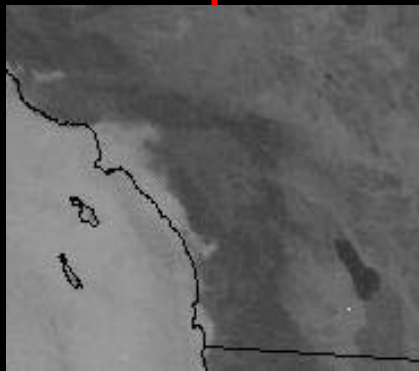
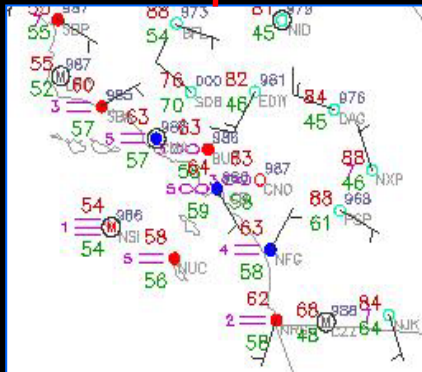
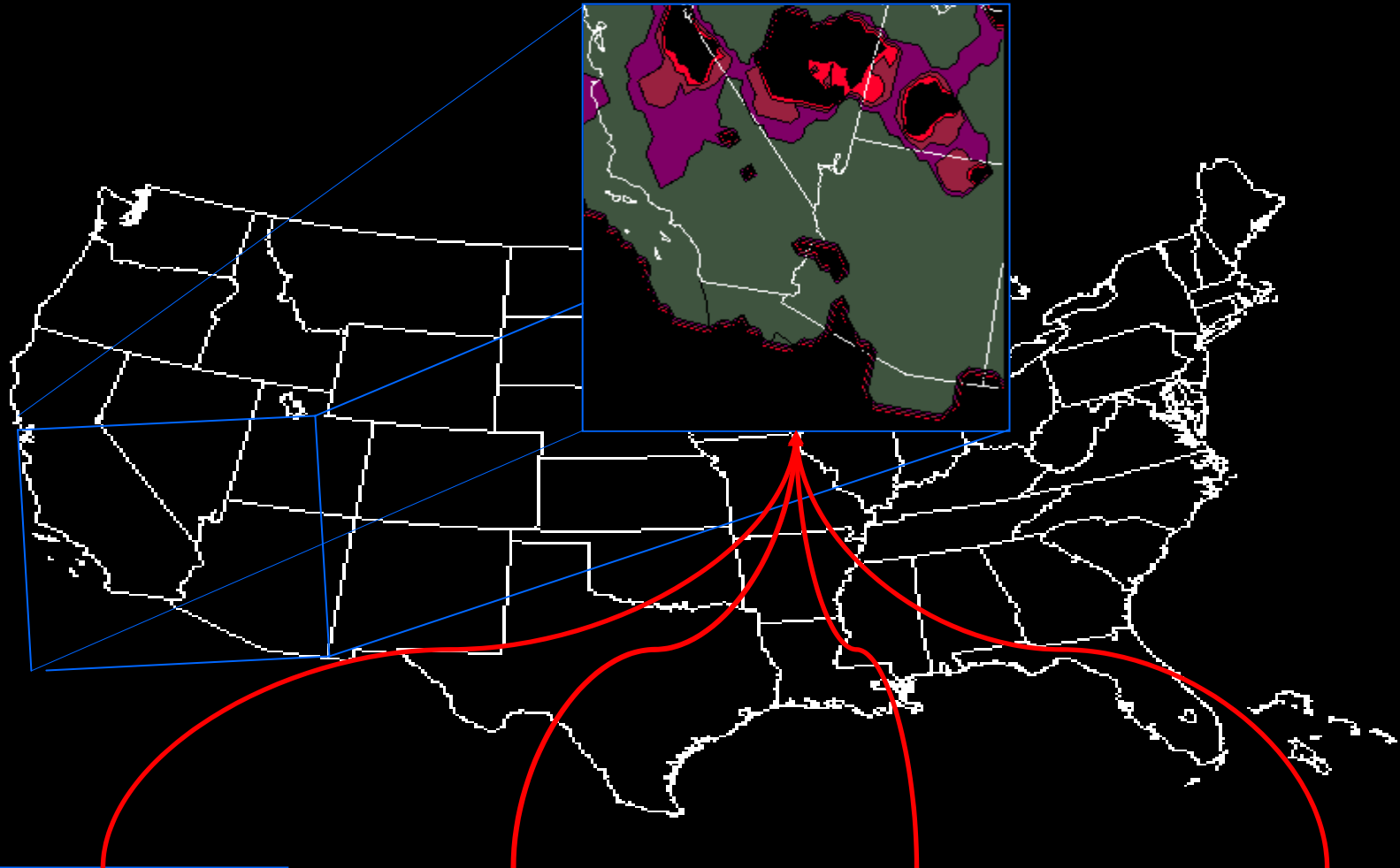
04/27/00 20Z



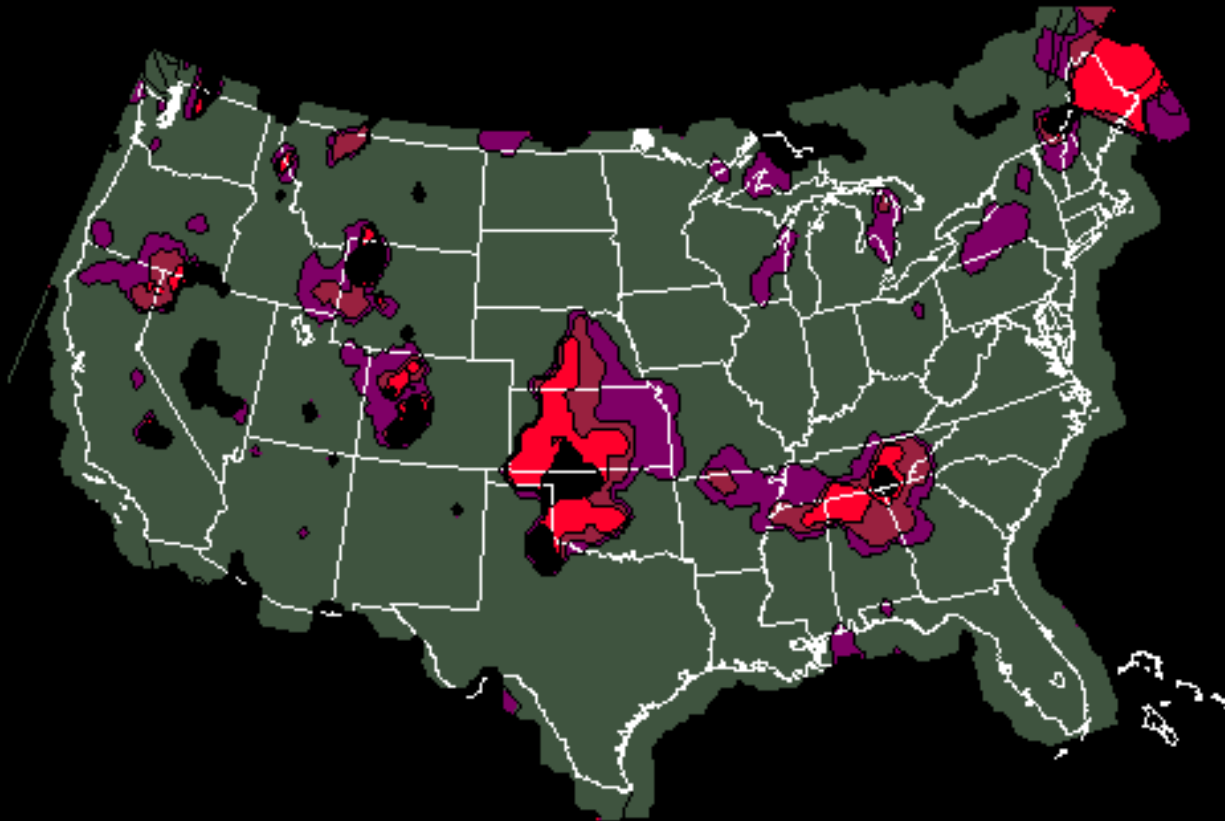
FLIGHT CAT.

04/27/00 20Z





Flight Cat (Jan 17 0523Z)



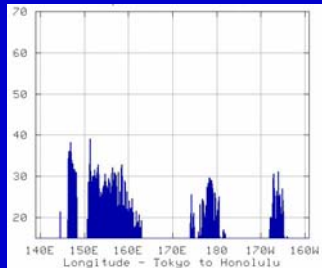
LIFR

IFR

MVFR

VFR

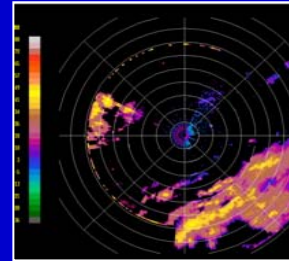
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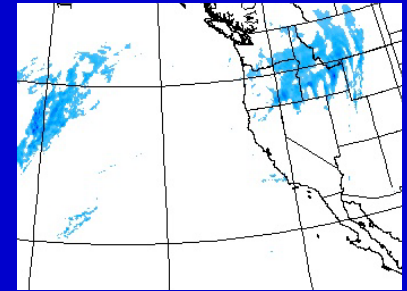
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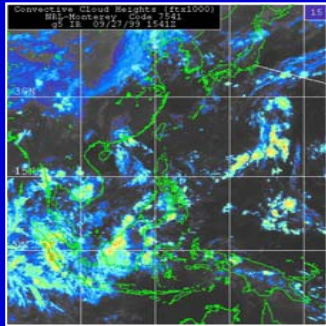
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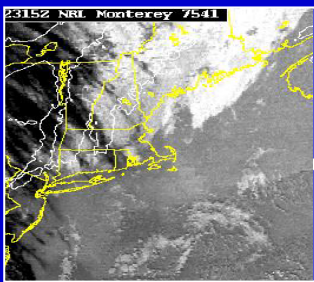
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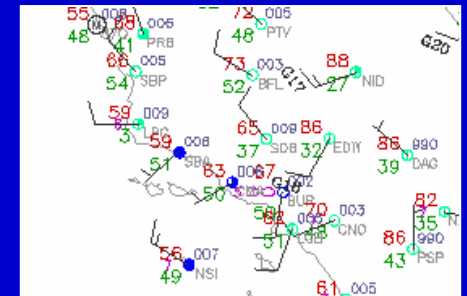
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Confidence Level

Summary

- C&V Program off to a good start
- NRL and NCAR working well together
- NPMOC-San Diego and AWC/ADDS in background waiting to participate
- Meets an important objective of NASA AvSP
- Three-year funding required to maintain program
- Major East Coast winter storm/C&V experiment being considered by FAA, NASA, and others

